FOREST PRODUCTS
Project Fact Sheet

COMMERCIALIZATION OF THE BIOFINE TECHNOLOGY FOR LEVULINIC ACID PRODUCTION FROM PAPER SLUDGE

BENEFITS

- Reduce cost for manufacturing levulinic acid
- Increase source of levulinic acid and other saleable chemicals (up to 25 million gallons/yr from typical plant)
- Produce the fuel, MTHF, at low cost ($0.50/gallon)
- Use a compact-sized production plant
- Avoid disposal costs for paper sludge and other forms of biomass
- Employ an environmentally benign process to make industrial chemicals
- Stimulate the hydrogen for fuel market (to produce MTHF)
- Create new jobs and a $30 billion-$50 billion market by 2020

APPLICATIONS

Derivatives of levulinic acid include methyl tetrahydrofuran (MTHF), a gasoline extender; diphenolic acid, an alternative to bisphenol A, for epoxy resins; tetrahydrofuran, a major solvent; 1,4 butanediol, an important polymer intermediate; succinic acid, a specialty chemical; and delta amino levulinic acid (DALA), the active chemical in a new group of herbicides and pesticides. Large-scale biomass conversions of 1,000 tons/day are feasible.

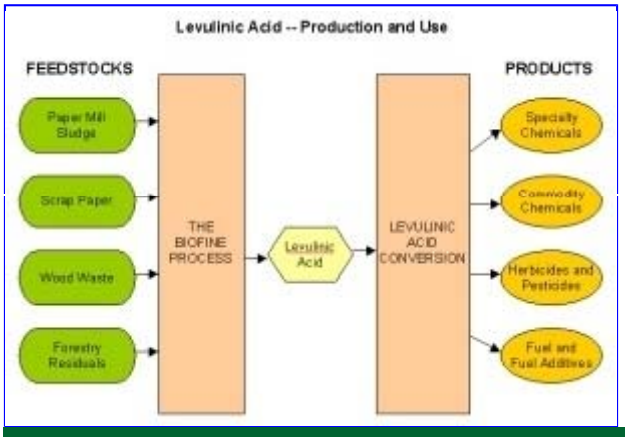
Technology Will Produce Highly Valuable Chemicals and Gasoline Additives from Cellulosic Wastes

A novel process, the "Biofine Technology," is available for processing biomass into useful chemical products and fuels. A major U.S. city typically produces more than 700,000 tons/year of municipal solid waste (MSW), and the Nation generates more than 200 million tons of MSW annually. More than half this waste consists of paper, cardboard, wood, and herbaceous material—cellulosic materials that are difficult to recycle and naturally resistant to chemical breakdown.

With the Biofine Technology, relatively low-grade waste cellulosic by-products from paper mills and other sources can be converted into levulinic acid, a versatile chemical that is an intermediary to several other products. Derivatives of the chemical include methyl tetrahydrofuran (MTHF), a gasoline extender that has been successfully road-tested in fuel blends, which demonstrates low volatility, high specific gravity, and a high oxygen content. Industrial chemicals manufactured from levulinic acid include tetrahydrofuran, 1,4 butanediol, diphenolic acid, succinic acid, gamma butyrolactone, angelicalactone, and N methylpyrrolidone. Levulinic acid currently has a high market price because of expensive starting materials required for its production. Commercialization of the Biofine Technology will offer alternative, cost-effective methods for manufacturing this chemical and its derivatives, including fuels, in the future. It could be a significant technology, for example, in agricultural regions where feedstock is plentiful.

The technology also has the potential to revolutionize the handling of cellulosic wastes. In addition to the by-products of paper mills, the process could reduce the accumulation of sewage sludge, waste wood, agricultural residues, and municipal solid waste.

The Biofine plant is compact enough for a 1000 (dry) ton per day plant to fit on a floating platform or ocean-going barge.



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ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY

PROJECT DESCRIPTION

Goal: To construct, test and operate a one-ton cellulosic feedstock per day, demonstration-scale plant to test the Biofine process for the production of levulinic acid from paper-mill waste.

A number of partners will help oversee the engineering of the project, provide site operation and feedstocks, market the levulinic acid, evaluate the demonstration, and conduct other management operations.

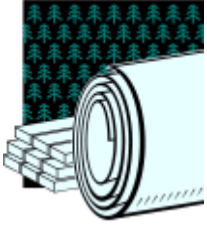
The conversion of cellulose to levulinic acid is accomplished via high-temperature, dilute-acid hydrolysis in a novel reactor configuration. Cellulose is first converted to soluble sugars, which are then converted to levulinic acid. Approximately 0.5 lb of levulinic acid is produced per pound of cellulose processed. Although the intended feedstock is primarily paper sludge, the use of MSW as feedstock will be tested for six weeks in the plant. Additional types of waste streams will also be tested for use in this process over the remainder of the year.

PROGRESS & MILESTONES

- Technology was tested in two pilot plants at different scales of operation.
- A grant was received from the Department of Energy the New York State Energy Research and Development Authority to construct the first commercial demonstration plant, in Glens Falls, NY.
- A large chemical company will purchase plant output of levulinic acid for one year.
- The plant has been in operation for one year testing various paper sludges. The MSW test is now in progress. (Aug, 1998)
- The next stage is to construct a large-scale commercial plant.

AWARDS, PATENTS, AND INVENTION RECORDS

- The Biofine Technology was awarded patents in the United States, Europe, and several other foreign countries.



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August 1998